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Barriers in Implementing Antibiotic Stewardship Program at Pediatric Units in Academic Hospitals in Thailand: A Qualitative Study

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Abstract

Objective: To explore the barriers that hinder and the facilitators that strengthen implementation of the antimicrobial stewardship (AMS) program at pediatric units in academic hospitals in Thailand.

Design: A qualitative study using thematic analysis of interviews with healthcare staff.

Setting: Five pediatric units in academic hospitals in Thailand

Participants: 20 healthcare workers and 10 AMS service providers who actively participated in AMS program in the sampled hospitals were included from purposive criterion.

Primary outcome measures: Qualitative, interpretive description with semi-structured individual interviews were digitally recorded and transcribed. The MAXQDA software was used to facilitate content analysis.

Results: In total, 4 themes, emerged from the data: (1) Organizational hierarchical culture and individual behaviors influence the acceptance and adherence to AMS implementation, (2) Adjust the mindset of healthcare worker regarding antimicrobial stewardship program is crucial, (3) Effective communication and collaboration among healthcare teams are the key to implement AMS programme, and (4) The steward's commitment to responsible and judicious use of antimicrobials is a facilitator to improve AMS programme implementation.

Conclusions: To implement antimicrobial stewardship in pediatric setting, there are many issues to overcome. The key barriers to focus were organization hierarchical culture and perception of healthcare workers. Support from hospital policy, effective communication with contextualized strategies should be considered to improve AMS programme implementation plans.

Strengths and limitations of this study

- Our study identified specific challenges and potential opportunities for implementing antimicrobial stewardship within the context of inpatient pediatric setting.
- The data was collected through interviews with both stewards and healthcare providers involved in antimicrobial stewardship.
- Our findings are specific to our institutions and may not be generalizable to other healthcare settings.

Introduction

Antimicrobial stewardship (AMS) programs are a strategy recommended by the Infectious Diseases Society of America (IDSA) to promote the judicious use of antibiotics, optimize patient outcomes, and reduce the risk of developing resistance[1]. AMS has multifaceted strategies such as prospective audit-and-feedback, prior authorization, education, clinical decision support, and rapid diagnostics[2]. Strategies selection should be based on the availability of facility-specific resources for consistent implementation and tailored to local settings[1].

Implementing antibiotic stewardship can be challenging because it involves changing knowledge, deeply held attitudes, cultural norms, and the emotionally influenced behaviors of clinicians and patients toward antibiotic prescribing and use[3]. Implementation science can help address this challenge. Implementation science principles can inform local antibiotic stewardship efforts and to identify gap between evidence-based practice and routine practice in real-world settings[4]. Implementation frameworks should be identified and employed to research on implementing AMS programme. Determinant frameworks such as the Consolidated Framework for Implementation Research (CFIR) can be used to understand different factors that enable or hinder the implementation process[5]. The CFIR model has been used to study the perceptions of antibiotic stewardship personnel regarding why their programs were successful by conducting a qualitative study across different hospital settings to examine perspectives of physician and pharmacist stewards about the dynamics within their team and contextual factors that facilitate the success of their programs[6].

In Thailand, AMS in pediatric setting is not widely implemented and the intervention is not highly accepted. Based on a previous study at a tertiary care center, overall acceptance of AMS programme recommendations for carbapenem de-escalation was only 57.8%[7]. Due to its low acceptance, implementation research is needed to explore reasons such as barriers and facilitators of implementing and inform how interventions should be adapted. In this study, researchers conducted implementation research on AMS at the five pediatric units in academic hospitals in Thailand to identify barriers and facilitators of implementing AMS across different settings.

Methods

A qualitative study with semi-structured interviews was conducted in 2023. We collected data from 5 academic tertiary care hospitals in Thailand. The site selection was conducted using convenient sampling, focusing on a center where pediatric infectious diseases specialists with less than 10 years of work experience. The Ethics Committee of Faculty of Medicine, Chulalongkorn University has approved the study (IRB. 236/65).

Study design

Semi-structured interview was conducted with healthcare providers. The qualitative study was conducted to identify 1) Barriers and facilitators of current AMS intervention at King Chulalongkorn Memorial Hospital (KCMH) where AMS implementation has been launched in pediatric setting since 2017, and 2) Barriers and facilitators to implement AMS at another 4 hospitals where AMS has not been established in pediatric setting. These include organizational context such as information technology support, staffing resources, organizational climate and culture, and leadership support. The interviews also assessed local context and barriers to implementation: stakeholder perceptions and attitudes, current antibiotic prescribing problems, and preferences for potential methods of implementation strategies. Interviews were conducted from both healthcare providers who involve antibiotic prescribing and steward teams who were AMS services providers.

Target population:

1) Health care providers (HCP)

Inclusion criteria: Healthcare providers who providing care at pediatric units at Department of Pediatrics, KCMH and another 4 hospitals (academic tertiary care hospitals: Charoenkrung Pracharak Hospital, Vachira Phuket Hospital, Trang Hospital, Hat Yai Hospital)

Exclusion criteria: Healthcare providers who worked less than 3 months duration of service at pediatric units.

2) Service providers of AMS teams (SP)

Inclusion criteria: Current healthcare providers who are steward teams at Pediatrics Department, KCMH, such as physicians, nurses, and pharmacists.

Exclusion criteria: Healthcare providers who had been involved with AMS services less than 3 months.

Sample size calculation for semi-structured interviews:

The number of participants interviewed initially set is 20 healthcare workers and 10 AMS service providers. Interviews will be continued until thematic saturation is reached[8].

Data Collection

Each semi-structured interview lasted 40-60 minutes. The interviews were audio recorded. An interview guide was created by the research team with guidance from a comprehensive literature review[8, 9,10, 11]. Open-ended questions asked about current prescribing practices, prior education about antibiotic stewardship, and views about the stewardship program at the hospital. Participants also answered the questionnaire regarding AMS implementation and interventions (Supplemental material). We used the CFIR model to inform interviews which was conducted among steward team and healthcare providers to identify barriers and facilitators of AMS implementation.

Data Analysis

Transcripts were analyzed using MaxQDA (VERBI Software, 2022)[12]. Transcript were coded inductively in an iterative manner by three independent reviewers (SA, PW, TJ) and coding discrepancies were resolved by consensus. Codes were used to conduct thematic analysis.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

In total of 30 interviewees, there were 24 physicians and 6 pharmacists. Regarding gender, 63% of the participants were female. The mean age was 37 years (range 26-57). There were 14 (47%) healthcare workers who work directly related to infectious diseases. Demographic characteristics of the participants were shown in Table 1.

Four themes were identified on the implementation of AMS in pediatric units in 5 academic hospitals in Thailand.

The Impact of Organizational Hierarchical Structure and Individual Behavioral Factors

Organizational culture and individual behaviors influence the acceptance and adherence to AMS implementation. Understanding the cultural context of a healthcare setting is important for tailoring interventions. Individual behaviors and resistance to change are also another factor which may be due to established routines, concerns about increased workload, or skepticism about the benefits of the program. Additionally, In Thailand, the context of seniority refers to the traditional cultural value placed on respecting and honoring elders or those who hold higher positions in an organization. This concept is deeply rooted in Thai culture and is an essential aspect of social interactions and relationships. In a hospital setting, the concept of seniority is also significant. This affects the AMS when steward team suggests an intervention to pediatric residents, but the final decision depends on senior attending. Also, the hospital system and culture did not support that steward team can directly convey to the senior attending staff. The opinions and decisions of senior colleagues are given more weight, and junior physician respect to them. In the opposite direction, the importance of expanding the concept of AMS and rational antimicrobial use should start at the medical student level to foster teamwork and improve patient care.

"Among medical staff, including attending physicians, there can be differing opinions about the appropriate use of antibiotics. This can lead to inconsistent empirical antibiotic therapy. Senior staff members often have the final say in antibiotic selection, which can override recommendations made based on ASP guidelines. (HCP02, Environmental context and resource)"

"A significant barrier is the prescribing behavior of healthcare providers and their fear of adverse outcomes. Due to the complexity of the cases in the tertiary care setting, frontline physicians may be hesitant to use narrower-spectrum antibiotics for fear of treatment failure or harm to the patient. While this is understandable, it can hinder the implementation of an ASP. (HCP04, Knowledge, Belief about consequence)"

"We should start educating medical students about the stewardship program while they are still in medical school. This will prepare them to understand the importance of rational antibiotic use. When they graduate and start working, they will be ready to apply this knowledge immediately" (SP01, Knowledge)"

The Mindset of Healthcare Workers Regarding AMS

Adjust the mindset of healthcare workers regarding antimicrobial stewardship program and identify and address concerns or barriers that healthcare workers may have regarding AMS. This could include concerns about patient satisfaction, fear of undertreatment, or lack of awareness. The participant from AMS team suggested to adjust mindset of the physician team. Different healthcare professionals may have varying perspectives and experiences regarding antibiotic stewardship. In some cases, physicians might have experienced conflicts with the stewardship team over specific patient cases, leading to a perception of friction between the two parties. Also, they might have concerns about the time takes to consult or the potential delays in initiating antibiotics. The steward participants discussed correcting the AMS team is not the "antibiotic police"; instead, they play a vital and supportive role in promoting responsible and effective antibiotic use in healthcare settings. They help healthcare providers make informed decisions about antibiotic prescriptions tailored to each patient's condition.

"ASP team must understand that frontline clinicians may have concerns, anxieties, or be dealing with complex or unstable patients. Therefore, ASP team is there to assist in patient care, not to stop antibiotic therapy. (SP01, Professional role)"

"ASP team should start suggestion by fostering mutual understanding. We are all working together to provide the best care for the patients. (SP02, Professional role)"

"Certainly, a major challenge is gaining the understanding of physicians from other specialties or the primary care team. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we change this perception and make primary teams see the ASP as a supportive specialty team focused on optimizing antimicrobial therapy? This is a significant challenge. (SP09, Social influence)"

Effective Communication and Collaboration

Effective communication and collaboration among healthcare teams are crucial for the success of AMS. Issues related to communication gaps, interdisciplinary collaboration, and hierarchies within healthcare settings were identified. The effective strategies should be developed and established for sustainable communication channel for the steward team, ensuring that all medical professionals are aware of the scope and work of the steward team. The participants also discussed the importance of

engaging other specialties with high antibiotic prescribing rates, such as hematology-oncology, critical care, and immunology, in the antimicrobial stewardship program.

"Antimicrobial steward team often have to negotiate with the prescribing physician. It can be difficult to immediately change these prescribing practices. However, what we can do is make adjustments after the initial antibiotic choice has been made, after a few days of monitoring, discuss the possibility of making adjustments. (HCP01, Professional role, Social influence)"

""Gaining the understanding of physicians from other specialties or the primary care team is crucial. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we make the primary care team understand that the ASP is not a team that stops treatment, but rather a team that assists in patient care? We are essentially a specialty team focused on antimicrobial management. (SP01, Social influence)"

"I would like to find a more sustainable way to inform the prescribers about the stewardship program, then it will be easier to work together. (SP08, Professional role)"

The steward's commitment

The steward's commitment to responsible and judicious use of antimicrobials is a facilitator to improve AMS programme implementation. Even though the lack of resources and staffing, AMS steward team are committed to patient safety with educational mindset. The participants discussed working as AMS team to prioritize patient safety by suggesting the appropriate use of antimicrobials. Furthermore, they are willing to continuously learn and stay updated on best practices in AMS, as well as to educate other healthcare professionals and patients about the importance of responsible antimicrobial use.

"I feel like it's a big job. It requires a lot of collaboration to manage, and I think it will take a long time to see any changes. We need to continuously educate involving medical staff, however, seeing those results takes time. (HCP04, Self-efficacy)"

"I enjoy doing this because I'm constantly learning new things. Additionally, it can be seen as a strategy to encourage pharmacists to develop their skills. (HCP06, Self-efficacy)"

"I feel like this work can improve patient care, especially in terms of reducing antibiotic resistance. We can provide healthcare providers involved in the ASP with valuable experience that they

can apply in their future roles. If, overall, things improve, that would be a rewarding outcome. (HCP01, Self-efficacy, Engaging)"

In terms of CFIR domain, AMS programme implementation at pediatric units in academic hospitals in Thailand were stratefied into following subthemes (Figure 1).

1. Barriers

1.1 Knowledge (CFIR domain: Characteristics of Individuals): AMS steward have to work to enhance the knowledge and understanding of healthcare providers regarding appropriate antibiotic use, including the latest guidelines and evidence-based practices.

1.2 Professional role (CFIR domain: Inner setting, Characteristics of Individuals): the steward team lacks the authority to directly intervene in prescribing practices. Consequently, their recommendations were ignored by individual clinicians.

1.3 Social influences (CFIR domain: Characteristics of Individuals): such as resistance from medical staff, lack of leadership, perceived unhelpful attitudes of clinicians. There is a tension between steward team and clinicians who feel their autonomy is being undermined and lead to resistance and a lack of buy-in from the individual clinicians.

1.4 Belief about consequences (CFIR domain: Characteristics of Individuals): Physicians might have experienced conflicts with the stewardship team over specific patient cases.

1.5 Environmental context and resources (CFIR domain: Inner setting): This includes lack of key personnel, competing priorities, lack of access to resources, problems with data and information systems, inadequate supply of laboratory diagnostic tests, and limited available antibiotic options.

2. Feelings and thoughts regarding AMS programme (CFIR domain: Characteristics of Individuals, Inner setting [readiness for implementation])

For the AMS steward who taking role in AMS; positive thoughts are the participants feel a sense of responsibility towards patient safety. Taking on a role in AMS aligns with the commitment to providing effective healthcare. Most of them feel happy and pride in contributing to efforts to combat antimicrobial resistance. While the negative thoughts are the participants feel resist due to additional workload. Some concern how to effectively communicate with the physicians.

3. Suggested interventions (CFIR domain: Intervention Characteristics, Process)

According to the distributed questionnaire regarding AMS implementation and interventions, the top three ranking of the interest level among the participants to support AMS implementation at their hospital were: 1) A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure) 2) A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use; and 3) Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use. The top five ranking of the interest level in antimicrobial stewardship program interventions to be most effective in their hospital were: 1) De-escalation therapy 2) Guideline implementation, and 3) Antibiogram, 4) Prospective audit and feedback, and 5) Pharmacokinetics and pharmacodynamics application in antibiotic dosing. In summary, major barriers and potential interventions for implementing AMS programme at pediatric units in academic hospitals in Thailand were shown in Table 2.

Discussion

The barriers and facilitators of implementing AMS programme at pediatric units in academic hospitals in Thailand were identified. The major themes from this qualitative study were organizational hierarchical culture and individual behaviors, social influences, effective communication and collaboration, and the positive mindset of AMS programme team.

Our study identified organizational hierarchical culture and individual behaviors as key barriers to AMS implementation. Studies from various settings consistently revealed inadequate knowledge and awareness of rational antibiotic use among physicians.[13] Antibiotic prescribing practices vary across countries. While many countries involve a wide range of healthcare providers in antibiotic prescriptions [13, 14], the prescribing practices in our study were distinct where specialists or senior physicians held primary decision-making authority. This hierarchical structure often led to the overruling of recommendations from the ASP team. The findings demonstrated the long-standing culture of seniority hindered AMS adoption. Despite the existence of AMS policies in the studied hospitals, they were not consistently endorsed or applied in practice.

Many studies documented complex behavioral and social influences on antimicrobial prescribing.[15] Our findings align with other studies that have evaluated barriers in relation to clinical decision making. Prior studies reported physician insecurity in patients with severe or nondefinitive diagnoses[16-18]. Similar to pediatric setting, most pediatricians stated that non-prescription of an antibiotic to potentially severely ill children generated more fear and insecurity than the consequences of an unnecessary antibiotic prescription.[18] Given the high rates of antimicrobial resistance in our study setting, pediatricians also experienced anxiety about not prescribing broad-spectrum antibiotics.

To resolve these challenges, adaptable, evidence-based interventions should be developed and implemented across various healthcare settings. An effective feedback tool also needs to be developed and implemented to engage the healthcare provider and impact on the patients' clinical outcomes.[19] Our study reported that healthcare provider engagement was crucial for successful AMS implementation. ASP recommendations should be communicated collaboratively, focusing on improving patient outcomes rather than criticizing the practices or being perceived as the "antibiotic police".[9, 20] From the previous study, formalized antibiotic stewardship meetings and ward rounds on a continuous and regular basis is one of the effective AMS intervention.[21] The AMS team can facilitate interdisciplinary rounds to address complex cases, bringing together expertise from specialists, infectious disease physicians, pharmacists, and other healthcare professionals.[22] This collaborative approach encourages shared decision-making and can lead to more rational antibiotic use.

A recent national survey in Thailand indicated that nearly 90% of hospitals had an ASP in 2021, often with a multidisciplinary team.[23] However, there is a shortage of ASP team members nationwide. Most team members are general practitioners or pharmacists lacking formal infectious disease training.[24] Understaff and underprioritizing of ASP are also global challenges.[25] Despite resource constraints and heavy patient workloads in the region[13], our study found that the stewardship team maintained a positive attitude toward combating antimicrobial resistance and was committed to professional development aligning with findings from previous study.[26] To further enhance their efforts, robust support systems, including hospital administrator, adequate laboratory capabilities, and improved information technology infrastructure, are essential.[24]

For the implication, antibiotic stewardship involves organization and hospital policy, hospital staff and antibiotic prescribers, local context in each setting, and individual behavior change should be considered. Overall, the success of antimicrobial stewardship programs relies on understanding and addressing the perspectives and concerns of healthcare workers. Creating a positive and supportive environment, providing ongoing education, and recognizing the contributions of those involved are essential components of a successful stewardship initiative. It requires a combination of educational, organizational, and cultural interventions. Based on behavior change wheel[27], we proposed potential interventions for implementing AMS programme at pediatric units in academic hospitals in Thailand as detailed in Table 2. Tailoring strategies to the specific challenges and culture of the healthcare environment is crucial for success.

Our findings highlight specific challenges and opportunities for AMS implementation within the context of inpatient pediatric care. However, there are limitations of this study. While thematic saturation was achieved with a relatively small sample size, the findings are specific to our institutions and may not be generalizable to other healthcare settings.

Conclusions

The implementation of antimicrobial stewardship in pediatric settings is challenging. Several key barriers that should be focused on successful integration were organization hierarchical culture, social influences. Effective communication with tailoring AMS strategies should be considered to improve antimicrobial stewardship programme implementation plans.

Contributor

SA and TJ conceived and designed the study. PW and TJ conducted and interviewed the participants. SA, PW, and TJ analyzed the data and interpreted the themes. TP supervised the study. SA wrote the first draft of the manuscript. All authors thoroughly reviewed and approved the manuscript.

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Competing interests

The authors have no competing interests to declare.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication

Not applicable.

Ethics approval

This study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB no. 0236/65).

Provenance and peer review

Not commissioned; externally peer reviewed.

Data availability statement

Anonymized data can be provided upon reasonable request. All study data consists of notes from staff interviews. The source data is confidential and not available for dissemination.

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Table 1. Baseline Characteristics of the 30 Interview Participants

Hospital levels	Number of interviewees	Profession	Gender	Mean age (range)
Healthcare workers	20	Physician 19 Pharmacist 1	Male 3 Female 7	39.2 (29-57)
AMS service providers	10	Physician 5 Pharmacist 5	Male 8 Female 12	36.3 (26-56)
Overall	30	Physician 24 (80%) Pharmacist 6 (20%)	Male 11 (37%) Female 19 (63%)	37.0 (26-57)

Table 2. Major barriers and potential interventions for implementing antimicrobial stewardship programme at pediatric units in academic hospitals.

Major barriers	**Potential interventions**
Beliefs/attitudes	Modelling e.g. peer influences, opinion from key leaders
Individual behavior, lack of knowledge	Education e.g. Interactive education sessions Training on specific topic of rational antimicrobial use
Lack of resources	Enablement: National and hospital policy to endorse adequate resources
Ineffective communication	Effective communication skills to convey the information clearly and persuasively

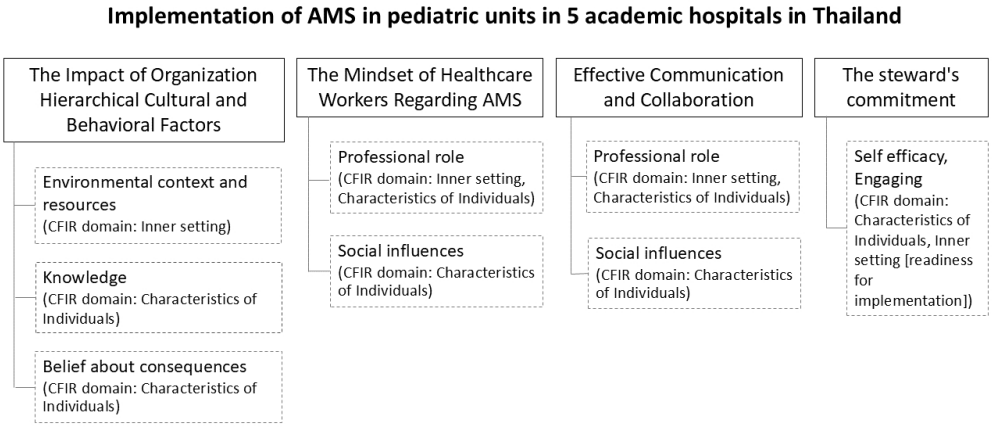

Figure 1. Themes and subthemes

275x154mm (118 x 118 DPI)

Supplemental material: Questionnaire

A. Please rank the following factors in order of their importance in implementing in your hospital to support the appropriate use of antibiotics (Rank from 1 as most important to 7 as least important)

- ☐ A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure
- ☐ A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use.
- ☐ Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use.
- ☐ Physician is the leader of antimicrobial stewardship activities.
- ☐ An information technology (IT) system that supports antimicrobial stewardship activities.
- ☐ Salary support for individuals working in antimicrobial stewardship.
- ☐ Hospital policies and administrative support.
- ☐ Others (please specify) ……..

B. Which of the following antimicrobial stewardship interventions do you think is most suitable and beneficial for promoting the appropriate use of antibiotics in your hospital?

ASP interventions	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Education					
Guideline implementation					
Antibiotic restriction and authorization					
Prospective audit and feedback					
IV-to-PO conversion					
Outpatient parenteral antimicrobial therapy					
De-escalation therapy					
Shortening duration of antimicrobial therapy					
Antibiogram					
Cascade antimicrobial susceptibility report					
Improve rapid diagnostic test					
Pharmacokinetics and pharmacodynamics application in antibiotic dosing					
Others (please specify) ……..					

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Barriers in Implementing Antibiotic Stewardship Program at Pediatric Units in Academic Hospitals in Thailand: A Qualitative Study

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Abstract

Objective: To explore the barriers that hinder and the facilitators that strengthen implementation of the antimicrobial stewardship (AMS) program at pediatric units in academic hospitals in Thailand.

Design: A qualitative study using thematic analysis of interviews with healthcare staff.

Setting: Five pediatric units in academic hospitals in Thailand

Participants: 20 healthcare workers and 10 AMS service providers who actively participated in AMS program in the sampled hospitals were included from purposive criterion.

Primary outcome measures: Qualitative, interpretive description with semi-structured individual interviews were digitally recorded and transcribed. The MAXQDA software was used to facilitate content analysis.

Results: In total, 4 themes, emerged from the data: (1) Organizational hierarchical culture and individual behaviors influence the acceptance and adherence to AMS implementation, (2) Changing healthcare workers' mindset to improve stewardship is crucial, (3) Effective communication and collaboration among healthcare teams are the key to implement AMS programme, and (4) Dedication to antimicrobial stewardship despite resource limitations is important to improve AMS programme implementation.

Conclusions: To implement antimicrobial stewardship in pediatric setting, there are many issues to overcome. The key barriers to focus were organization hierarchical culture and perception of healthcare workers. Support from hospital policy, effective communication with contextualized strategies should be considered to improve AMS programme implementation plans.

Strengths and limitations of this study

- The study reports the challenges and potential opportunities for implementing antimicrobial stewardship in the inpatient pediatric setting.
- The study highlights institutional and cultural impediments to AMS adoption, especially in low- and middle-income settings.
- The study focus on academic tertiary care hospitals, combined with specific inclusion and exclusion criteria.
- The data was collected through interviews with both stewards and healthcare providers involved in antimicrobial stewardship.
- The findings may have limited generalizability to other healthcare settings.

Introduction

Antimicrobial stewardship (AMS) programs are a strategy to promote the judicious use of antibiotics, optimize patient outcomes, and reduce the risk of developing resistance.[1] AMS has multifaceted strategies such as prospective audit-and-feedback, prior authorization, education, clinical decision support, and rapid diagnostics.[2] Strategies selection should be based on the availability of facility-specific resources for consistent implementation and tailored to local settings.[1] Implementing antibiotic stewardship can be challenging because it involves changing knowledge, deeply held attitudes, cultural norms, and the emotionally influenced behaviors of clinicians and patients toward antibiotic prescribing and use.[3] Implementation science can help address this challenge. Implementation science principles can inform local antibiotic stewardship efforts and to identify gap between evidence-based practice and routine practice in real-world settings.[4] Implementation frameworks should be identified and employed to research on implementing AMS programme. Determinant frameworks such as the Consolidated Framework for Implementation Research (CFIR) can be used to understand different factors that enable or hinder the implementation process.[5, 6] The CFIR model has been used to study the perceptions of antibiotic stewardship personnel regarding why their programs were successful by conducting a qualitative study across different hospital settings to examine contextual factors that facilitate the success of their programs.[7]

Prescribing the correct antibiotics for children requires careful decision, and errors in dosing can have serious consequences. However, in resource-limited settings, healthcare providers treating children often lack specialized training in pediatric infectious diseases or antibiotic stewardship, further affecting their ability to make informed prescribing decisions. In low- and middle-income settings, there are unique difficulties encountered in pediatric care regarding AMS such as limited access to diagnostics, unavailable antibiotic formulations, lack of education, and limited resource of healthcare (staffing and equipment).[8] A published study highlighted that the most common perceived barriers as to pediatric AMS were lack of education about antibiotics and lack of support from hospital management. Furthermore, an additional barrier in low- and middle-income settings was lack of recognition of AMS importance by senior doctors.[8] In addition, prescribing behavior among colleagues and hierarchical structure within the medical field were found as factors under the social influences domain.[9]

In Thailand, AMS in pediatric setting is not widely implemented and the intervention is not highly accepted. Based on a previous study at a tertiary care center, overall acceptance of AMS programme recommendations for carbapenem de-escalation was only 57.8%.[10] Due to its low acceptance, implementation research is needed to explore reasons such as barriers and facilitators of implementing and inform how interventions should be adapted. In this study, researchers conducted implementation research on AMS at the five pediatric units in academic hospitals in Thailand to identify barriers and facilitators of implementing AMS across different settings.

Methods

A qualitative study with semi-structured interviews was conducted in 2022 to gather data from healthcare providers. The Ethics Committee of Faculty of Medicine, Chulalongkorn University has approved the study (IRB. 236/65).

Study design

Semi-structured interview was conducted with healthcare providers. The qualitative study was conducted to identify 1) Barriers and facilitators of current AMS intervention at King Chulalongkorn Memorial Hospital (KCMH) where AMS implementation has been launched in pediatric setting since 2017, and 2) Barriers and facilitators to implement AMS at another 4 hospitals where AMS has not been established in pediatric setting. These include organizational context such as information technology support, staffing resources, organizational climate and culture, and leadership support. The interviews also assessed local context and barriers to implementation: stakeholder perceptions and attitudes, current antibiotic prescribing problems, and preferences for potential methods of implementation strategies.

Study Setting and Participants

The study was conducted by the Faculty of Medicine, Chulalongkorn University. We collected data from 5 academic tertiary care hospitals in Thailand. The site selection was recruited using convenient sampling, focusing on a center where pediatric infectious diseases specialists with less than 10 years of work experience. Interviews were conducted with both healthcare providers who involve antibiotic prescribing and steward teams who were AMS services providers.

Target population:

1) Health care providers (HCP)

Inclusion criteria: Healthcare providers who providing care at pediatric units at Department of Pediatrics, KCMH and another 4 hospitals (academic tertiary care hospitals: Charoenkrung Pracharak Hospital, Vachira Phuket Hospital, Trang Hospital, Hat Yai Hospital)

Exclusion criteria: Healthcare providers who worked less than 3 months duration of service at pediatric units.

2) Service providers of AMS teams (SP)

Inclusion criteria: Current healthcare providers who are steward teams at Pediatrics Department, KCMH, such as physicians, nurses, and pharmacists.

Exclusion criteria: Healthcare providers who had been involved with AMS services less than 3 months.

Sample size calculation for semi-structured interviews:

The initial target of the number of participants was to interview 20 healthcare workers and 10 AMS service providers. Interviews continued until thematic saturation was reached.[11] Ultimately, thematic saturation was achieved, and no new barriers or enablers were identified.

Interview Guide and Data Collection

An interview guide was created by the research team with guidance from a comprehensive literature review.[11, 12,13, 14] We used the CFIR model to inform interviews which were conducted among steward team and healthcare providers to identify barriers and facilitators of AMS implementation. Open-ended questions asked about current prescribing practices, prior education about antibiotic stewardship, and views about the stewardship program at the hospital. Participants also answered the questionnaire regarding AMS implementation and interventions (Supplemental material). The interview guide was piloted on two clinicians and revised based on feedback from the study team. Co-investigators (PW, TJ) conducted the interviews. Each semi-structured interview lasted 40-60 minutes. All participants provided informed consent to participate. The participant information sheet outlining the study was provided to all potential participants. Participants were informed of their rights and confidentiality was assured. Their written consent was then obtained before each interview started. The

interviews were audio recorded. The interviews began on 24 August 2022 and were completed on 6 Oct 2022. The codebook was initially developed based on a review of the literature and the interview guide. It was then iteratively refined through a process of pilot coding and discussion among the research team.

Data Analysis

Transcripts were analyzed using MaxQDA (VERBI Software, 2022).[15] Transcript were coded inductively in an iterative manner by three independent reviewers (SA, PW, TJ). We employed intercoder reliability checks using Cohen's Kappa >0.8. The coding discrepancies have been further discussed and were resolved by consensus. The research team used a combined inductive and deductive approach to code and analyze data. Main themes were identified through an inductive process while CFIR domains were used to deductively code for the subtheme. All interviews were conducted in Thai. Illustrative quotes were translated into English by one translator, then back-translated and reviewed by a second to ensure accuracy and maintain data integrity.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

In total of 30 interviewees, there were 24 physicians and 6 pharmacists. Regarding gender, 63% of the participants were female. The mean age was 37 years (range 26-57). There were 14 (47%) healthcare workers who work directly related to infectious diseases. Demographic characteristics of the participants were shown in Table 1.

Four themes were identified on the implementation of AMS in pediatric units in 5 academic hospitals in Thailand. These themes and subthemes are summarized in Table 2. Themes and subthemes linked to CFIR are presented in Figure 1.

The Impact of Organization and Individual Factors

Hierarchical Influence on Prescribing

In Thailand, the context of seniority refers to the traditional cultural value placed on respecting and honoring elders or those who hold higher positions in an organization. This concept is deeply rooted in Thai culture and is an essential aspect of social interactions and relationships. In a hospital setting, participants reported that the concept of seniority was significant. This affects the AMS when steward team suggests an intervention to pediatric residents, but the final decision depends on senior attending. Participants noted that the existing hospital system and culture did not readily support direct communication from the stewardship team to senior attending staff, potentially creating a barrier to implementing AMS recommendations.

"Well, sometimes you know the senior attendings might prescribe antibiotic, and you think, 'Maybe that's not the best choice,' but you don't really want to say anything. They have so much more experience." (HCP10)

"Among medical staff, including attending physicians, there can be differing opinions about the appropriate use of antibiotics. This can lead to inconsistent empirical antibiotic therapy. Senior staff members often have the final say in antibiotic selection, which can override recommendations made based on ASP guidelines." (HCP02)

Resource Limitations and Systemic Barriers

The participants reported the resource limitations such as lack of key personnel, competing priorities, lack of access to resources, problems with data and information systems, inadequate supply of laboratory diagnostic tests, and limited available antibiotic options.

"We as an ASP pharmacist had obstacles regarding the knowledge and number of key personnel. The expertise in antibiotics may still be limited to a small number of people. A challenge for us is the limited knowledge and number of staff with expertise, especially for complex antibiotic use." (HCP06)

"It's put the effort to track and report antibiotic use because our electronic medical record system is not fully support. This made really hard to monitor trends and identify areas for improvement." (SP02)

Knowledge and Beliefs Impacting Prescribing

AMS steward have to work to enhance the knowledge and understanding of healthcare providers regarding appropriate antibiotic use, including the latest guidelines and evidence-based practices. Individual behaviors and resistance to change are also another factor which may be due to established prescribing routines. The participants reported concerns of the frontline physicians about the benefits of the program, or fear of adverse outcomes and established prescribing habits which can act as barriers to change.

"A significant barrier is the prescribing behavior of healthcare providers and their fear of adverse outcomes. Due to the complexity of the cases in the tertiary care setting, frontline physicians may be hesitant to use narrower-spectrum antibiotics for fear of treatment failure or harm to the patient. While this is understandable, it can hinder the implementation of an ASP. (HCP04)"

To address this, participants suggested the importance of integrating AMS principles and rational antimicrobial use into medical education at the medical student level. This early exposure, they argued, would foster a culture of teamwork and promote improved patient care within the future healthcare system.

"We should start educating medical students about the stewardship program while they are still in medical school. This will prepare them to understand the importance of rational antibiotic use. When they graduate and start working, they will be ready to apply this knowledge immediately" (SP01)"

Changing healthcare workers' mindset to improve stewardship

Addressing Misconceptions and Building Trust

Changing healthcare workers' mindset to improve stewardship and identify and address concerns or barriers that healthcare workers may have regarding AMS. This could include concerns about patient satisfaction, fear of undertreatment, or lack of awareness. The participant from AMS team suggested to adjust mindset of the physician team. Different healthcare professionals may have varying perspectives and experiences regarding antibiotic stewardship. In some cases, physicians might have experienced conflicts with the stewardship team over specific patient cases, leading to a perception of friction between the two parties. Also, they might have concerns about the time takes to consult or the

potential delays in initiating antibiotics. The steward participants discussed correcting the AMS team is not the "antibiotic police"; instead, they play a vital and supportive role in promoting responsible and effective antibiotic use in healthcare settings. They help healthcare providers make informed decisions about antibiotic prescriptions tailored to each patient's condition.

"ASP team must understand that frontline clinicians may have concerns, anxieties, or be dealing with complex or unstable patients. Therefore, ASP team is there to assist in patient care, not to stop antibiotic therapy. (SP01)"

Navigating Authority and Autonomy

The steward team reported lacks the authority to directly intervene in prescribing practices. Consequently, their recommendations were ignored by individual clinicians. It emphasizes the need for effective communication and collaboration strategies. Social influences such as resistance from medical staff, lack of leadership, perceived unhelpful attitudes of clinicians. There is a tension between steward team and clinicians who feel their autonomy is being undermined and lead to resistance and a lack of buy-in from the individual clinicians.

"We can make suggestions, but at the end of the day, it's up to the primary physician to decide what to do. We don't have any real power to enforce." (SP06)

"Certainly, a major challenge is gaining the understanding of physicians from other specialties or the primary care team. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we change this perception and make primary teams see the ASP as a supportive specialty team focused on optimizing antimicrobial therapy? This is a significant challenge." (SP09)

Effective Communication and Collaboration for the success of AMS

Establishing Communication Channels for Stewardship Integration

Effective communication and collaboration among healthcare teams are crucial for the success of AMS. Issues related to communication gaps, interdisciplinary collaboration, and hierarchies within healthcare settings were reported. The service providers suggested that the effective strategies should be developed and established for sustainable communication channel for the steward team, ensuring that all medical professionals are aware of the scope and work of the steward team.

"Gaining the understanding of physicians from other specialties or the primary care team is crucial. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we make the primary care team understand that the ASP is not a team that stops treatment, but rather a team that assists in patient care? We are essentially a specialty team focused on antimicrobial management." (SP01)

"I would like to find a more sustainable way to inform the prescribers about the stewardship program, then it will be easier to work together. (SP08)"

Overcoming Perceptual Barriers and Fostering Mutual Understanding

This subtheme focuses on the need to address negative perceptions and misconceptions about AMS teams and their role, and to build a foundation of mutual understanding and respect between AMS teams and other healthcare professionals. The participants reported they might have experienced conflicts with the stewardship team over specific patient cases. The participants also discussed the importance of engaging other specialties with high antibiotic prescribing rates, such as hematology-oncology, critical care, and immunology, in the antimicrobial stewardship program.

"Antimicrobial steward team often have to negotiate with the prescribing physician. It can be difficult to immediately change these prescribing practices. However, what we can do is make adjustments after the initial antibiotic choice has been made, after a few days of monitoring, discuss the possibility of making adjustments. (HCP01)"

"ASP team should start suggestion by fostering mutual understanding. We are all working together to provide the best care for the patients." (SP02)

Dedication to Antimicrobial Stewardship Despite Resource Limitations

Intrinsic Motivation and Professional Fulfillment

Even though the lack of resources and staffing, AMS steward team reported a sense of professional fulfillment experienced. The participants discussed working as AMS team to prioritize patient safety by suggesting the appropriate use of antimicrobials. Furthermore, they are willing to continuously learn and stay updated on best practices in AMS, as well as to educate other healthcare professionals and patients about the importance of responsible antimicrobial use.

"I feel like this work can improve patient care, especially in terms of reducing antibiotic resistance. We can provide healthcare providers involved in the ASP with valuable experience that they can apply in their future roles. If, overall, things improve, that would be a rewarding outcome. (HCP01)"

"I feel like it's a big job. It requires a lot of collaboration to manage, and I think it will take a long time to see any changes. We need to continuously educate involving medical staff, however, seeing those results takes time. (HCP04)"

"I enjoy doing this because I'm constantly learning new things. Additionally, it can be seen as a strategy to encourage pharmacists to develop their skills." (HCP06)

The Reality of Workload

A reported drawback was the participants' feeling of resistance due to additional workload. Some concern how to effectively communicate with the physicians.

" This task adds to the workload. I also feel it's a difficult and challenging task because it might involve dealing with many people and many groups like this. And they might have both those who agree and those who disagree." (HCP04)

"Concerning communication, generally speaking, even if we have a good reason, if our position is pharmacist, it's hard to speak up to doctors" (SP03)

Regarding the distributed questionnaire regarding AMS implementation and interventions, the top three ranking of the interest level among the participants to support AMS implementation at their hospital were: 1) A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure) 2) A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use; and 3) Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use. The top five ranking of the interest level in antimicrobial stewardship program interventions to be most effective in their hospital were: 1) De-escalation therapy 2) Guideline implementation, and 3) Antibiogram, 4) Prospective audit and feedback, and 5) Pharmacokinetics and pharmacodynamics application in antibiotic dosing.

Discussion

The barriers and facilitators of implementing AMS programme at pediatric units in academic hospitals in Thailand were identified. The major themes from this qualitative study were organizational hierarchical culture and individual behaviors, social influences to improve healthcare workers' mindset, effective communication and collaboration, and the positive mindset of AMS programme team.

Our study identified organizational hierarchical culture and individual behaviors as key barriers to AMS implementation. These factors influence acceptance and adherence to AMS implementation. Understanding the specific cultural context of a healthcare setting is important for tailoring effective interventions. Studies from various settings consistently revealed inadequate knowledge and awareness of rational antibiotic use among physicians.[16] Addressing knowledge gaps, enhances education on appropriate antimicrobial prescribing while in medical school is a key target for improvement.[17]

Antibiotic prescribing practices vary across countries. While many countries involve a wide range of healthcare providers in antibiotic prescriptions [16, 18], the prescribing practices in our study were distinct where specialists or senior physicians held primary decision-making authority. Consistent with a published study, hierarchical structures and a lack of recognition of AMS importance by senior doctors emerged as barriers in low- and middle- income settings.[9, 19] The findings demonstrated the long-standing culture of seniority hindered AMS adoption. Despite the existence of AMS policies in the studied hospitals, they were not consistently endorsed or applied in practice.

Many studies documented complex behavioral and social influences on antimicrobial prescribing.[20] Our findings align with other studies that have evaluated barriers in relation to clinical decision making. Prior studies reported physician insecurity in patients with severe or nondefinitive diagnoses.[21-23] Similar to pediatric setting, most pediatricians stated that non-prescription of an antibiotic to potentially severely ill children generated more fear and insecurity than the consequences of an unnecessary antibiotic prescription.[23] Given the high rates of antimicrobial resistance in our study setting, pediatricians also experienced anxiety about not prescribing broad-spectrum antibiotics. To resolve these challenges, adaptable, evidence-based interventions should be developed and implemented across various healthcare settings. An effective feedback tool also needs to be developed and implemented to engage the healthcare provider and impact on the patients' clinical outcomes.[24] Our

study reported that healthcare provider engagement was crucial for successful AMS implementation. ASP recommendations should be communicated collaboratively, focusing on improving patient outcomes rather than criticizing the practices or being perceived as the "antibiotic police".[12, 25] From the previous study, formalized antibiotic stewardship meetings and ward rounds on a continuous and regular basis is one of the effective AMS intervention.[26] The AMS team can facilitate interdisciplinary rounds to address complex cases, bringing together expertise from specialists, infectious disease physicians, pharmacists, and other healthcare professionals.[27] This collaborative approach encourages shared decision-making and can lead to more rational antibiotic use.

A recent national survey in Thailand indicated that nearly 90% of hospitals had an ASP in 2021, often with a multidisciplinary team.[28] However, there is a shortage of ASP team members nationwide. Most team members are general practitioners or pharmacists lacking formal infectious disease training.[29] Understaff and underprioritizing of ASP are also global challenges.[30] Despite resource constraints and heavy patient workloads in the region[16], our study found that the stewardship team maintained a positive attitude toward combating antimicrobial resistance and was committed to professional development aligning with findings from previous study.[31] To further enhance their efforts, robust support systems, including hospital administrator, adequate laboratory capabilities, and improved information technology infrastructure, are essential.[29]

For the implication, antibiotic stewardship involves organization and hospital policy, hospital staff and antibiotic prescribers, local context in each setting, and individual behavior change should be considered. Overall, the success of antimicrobial stewardship programs relies on understanding and addressing the perspectives and concerns of healthcare workers. Creating a positive and supportive environment, providing ongoing education, and recognizing the contributions of those involved are essential components of a successful stewardship initiative. It requires a combination of educational, organizational, and cultural interventions. Tailoring strategies to the specific challenges and culture of the healthcare environment is crucial for success. The Behavior Change Wheel (BCW) is a systematic framework designed to guide the development of effective interventions.[32] It works by first requiring a thorough understanding of the target behavior using the COM-B model (Capability, Opportunity, Motivation). For example, if a key barrier is someone's beliefs about the behavior, potential

interventions might focus on persuasion, modeling, or education to change those beliefs. Similarly, if a lack of resources is identified as a barrier, an enablement intervention, such as endorsing a supportive hospital policy or providing staff and equipment, could be implemented.

Our findings highlight specific challenges and opportunities for AMS implementation within the context of inpatient pediatric care. Key strengths of the study include identifying institutional and cultural impediments to AMS adoption, especially in low- and middle-income situations. Furthermore, it identifies the dedication and professional fulfillment of AMS teams, which can be leveraged to improve AMS initiatives. However, it is important to acknowledge several methodological limitations. Firstly, the findings may not be directly transferable to all settings due to differences in organizational structure, resource availability, and patient populations. Secondly, conducting qualitative research in a hierarchical corporate culture presents challenges, potentially leading to power dynamics influencing participants' responses and a reluctance to express opinions. Lastly, there is the possibility of social desirability bias influencing participants' responses during the interviews. Although we ensured anonymity and confidentiality to minimize this bias, we acknowledge that it may not have been entirely eliminated.

Conclusions

The implementation of antimicrobial stewardship in pediatric settings is challenging. The key barriers to focus were organization hierarchical culture and perception of healthcare workers. The next steps for implementing AMS programs in Thai pediatric hospitals could involve integrating AMS principles into medical education, fostering an approach to promote shared decision-making regarding rational antibiotic use, and improve healthcare workers' mindset toward stewardship.

Contributor

SA and TJ conceived and designed the study. PW and TJ conducted and interviewed the participants. SA, PW, and TJ analyzed the data and interpreted the themes. TP supervised the study. SA wrote the first draft of the manuscript. All authors thoroughly reviewed and approved the manuscript. SA is responsible for the overall content as guarantor.

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Competing interests

The authors have no competing interests to declare.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication

Not applicable.

Ethics approval

This study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB no. 0236/65). All participants provided informed consent to participate in the study.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data availability statement

Anonymized data can be provided upon reasonable request. All study data consists of notes from staff interviews. The source data is confidential and not available for dissemination.

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Table 1. Baseline Characteristics of the 30 Interview Participants

Hospital levels	Number of interviewees	Profession	Gender	Mean age (range)
Healthcare workers	20	Physician 19 Pharmacist 1	Male 3 Female 7	39.2 (29-57)
AMS service providers	10	Physician 5 Pharmacist 5	Male 8 Female 12	36.3 (26-56)
Overall	30	Physician 24 (80%) Pharmacist 6 (20%)	Male 11 (37%) Female 19 (63%)	37.0 (26-57)

Table 2. Summary of themes and subthemes

Themes	Subthemes	Related CFIR Domains
The Impact of Organization and Individual Factors	Hierarchical Influence on Prescribing	Inner Setting - Culture
	Resource Limitations and Systemic Barriers	Inner Setting - Available Resources
	Knowledge and Beliefs Impacting Prescribing	Characteristics of Individuals - Implementation Team Members, Capability
Changing healthcare workers' mindset to improve stewardship	Addressing Misconceptions and Building Trust	Characteristics of Individuals - Implementation Team Members
	Navigating Authority and Autonomy	Inner Setting – Relational Connections, Communications
Effective communication and collaboration among healthcare teams	Overcoming Perceptual Barriers and Fostering Mutual Understanding	Characteristics of Individuals - Implementation Team Members
	Establishing Communication Channels for Stewardship Integration	Inner Setting - Communications
Dedication to antimicrobial stewardship despite resource limitations	Intrinsic Motivation and Professional Fulfillment	Characteristics of Individuals – Motivation, Need
	The Reality of Workload	Intervention Characteristics - Complexity, Inner setting - Implementation Climate

Figure 1. Themes and subthemes linked to CFIR

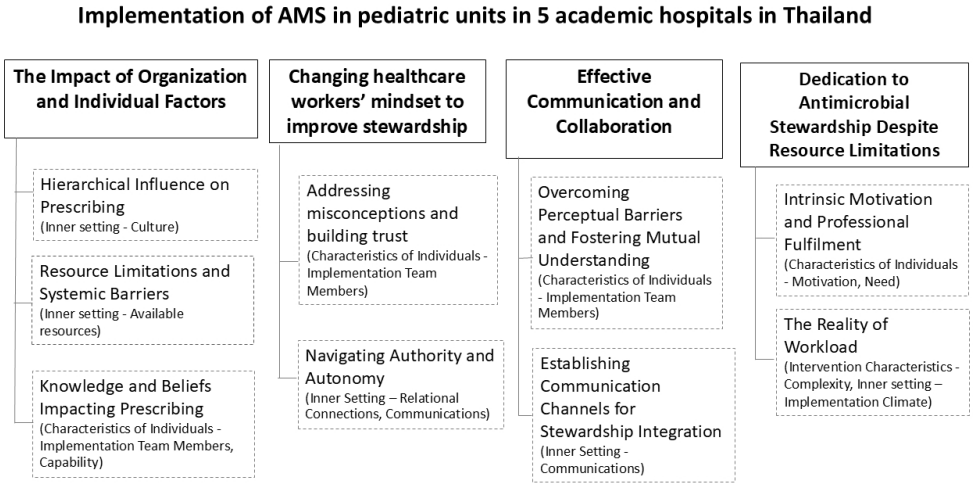

Figure 1. Themes and subthemes linked to CFIR

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Supplemental material: Questionnaire

A. Please rank the following factors in order of their importance in implementing in your hospital to support the appropriate use of antibiotics (Rank from 1 as most important to 7 as least important)

- A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure
- A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use.
- Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use.
- Physician is the leader of antimicrobial stewardship activities.
- An information technology (IT) system that supports antimicrobial stewardship activities.
- Salary support for individuals working in antimicrobial stewardship.
- Hospital policies and administrative support.
- Others (please specify) ……..

B. Which of the following antimicrobial stewardship interventions do you think is most suitable and beneficial for promoting the appropriate use of antibiotics in your hospital?

ASP interventions	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Education					
Guideline implementation					
Antibiotic restriction and authorization					
Prospective audit and feedback					
IV-to-PO conversion					
Outpatient parenteral antimicrobial therapy					
De-escalation therapy					
Shortening duration of antimicrobial therapy					
Antibiogram					
Cascade antimicrobial susceptibility report					
Improve rapid diagnostic test					
Pharmacokinetics and pharmacodynamics application in antibiotic dosing					
Others (please specify) ……..					

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Barriers in Implementing Antibiotic Stewardship Program at Pediatric Units in Academic Hospitals in Thailand: A Qualitative Study

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Keywords: Antimicrobials, Antibiotics, Implementation, Pediatrics, Stewardship

Abstract

Objective: To explore the barriers that hinder and the facilitators that strengthen implementation of the antimicrobial stewardship (AMS) program at pediatric units in academic hospitals in Thailand.

Design: A qualitative study using thematic analysis of interviews with healthcare staff.

Setting: Five pediatric units in academic hospitals in Thailand

Participants: 20 healthcare workers and 10 AMS service providers who actively participated in AMS program in the sampled hospitals were included from purposive criterion.

Primary outcome measures: Qualitative, interpretive description with semi-structured individual interviews were digitally recorded and transcribed. The MAXQDA software was used to facilitate content analysis.

Results: In total, 4 themes, emerged from the data: (1) Organizational hierarchical culture and individual behaviors influence the acceptance and adherence to AMS implementation, (2) Changing healthcare workers' mindset to improve stewardship is crucial, (3) Effective communication and collaboration among healthcare teams are the key to implement AMS programme, and (4) Dedication to antimicrobial stewardship despite resource limitations is important to improve AMS programme implementation.

Conclusions: To implement antimicrobial stewardship in pediatric setting, there are many issues to overcome. The key barriers to focus were organization hierarchical culture and perception of healthcare workers. Support from hospital policy, effective communication with contextualized strategies should be considered to improve AMS programme implementation plans.

Strengths and limitations of this study

- The study focuses on academic tertiary care hospitals, combined with specific inclusion and exclusion criteria.
- The data was collected through interviews with both stewards and healthcare providers involved in antimicrobial stewardship.
- A combined inductive and deductive approach was used for coding and data analysis.
- The findings may have limited generalizability to other healthcare settings.

Introduction

Antimicrobial stewardship (AMS) programs are a strategy to promote the judicious use of antibiotics, optimize patient outcomes, and reduce the risk of developing resistance.[1] AMS has multifaceted strategies such as prospective audit-and-feedback, prior authorization, education, clinical decision support, and rapid diagnostics.[2] Strategies selection should be based on the availability of facility-specific resources for consistent implementation and tailored to local settings.[1] Implementing antibiotic stewardship can be challenging because it involves changing knowledge, deeply held attitudes, cultural norms, and the emotionally influenced behaviors of clinicians and patients toward antibiotic prescribing and use.[3] Implementation science can help address this challenge. Implementation science principles can inform local antibiotic stewardship efforts and to identify gap between evidence-based practice and routine practice in real-world settings.[4] Implementation frameworks should be identified and employed in research on implementing AMS programme. Determinant frameworks such as the Consolidated Framework for Implementation Research (CFIR) can be used to understand different factors that enable or hinder the implementation process.[5, 6] The CFIR model has been used to study the perceptions of antibiotic stewardship personnel regarding why their programs were successful by conducting a qualitative study across different hospital settings to examine contextual factors that facilitate the success of their programs.[7]

Prescribing the correct antibiotics for children requires careful decision-making, as errors in dosing can have serious consequences. However, in resource-limited settings, healthcare providers treating children often lack specialized training in pediatric infectious diseases or antibiotic stewardship, further affecting their ability to make informed prescribing decisions. In low- and middle-income settings, there are unique difficulties encountered in pediatric care regarding AMS such as limited access to diagnostics, unavailable antibiotic formulations, lack of education, and limited resource of healthcare (staffing and equipment).[8] A published study highlighted that the most commonly perceived barriers to pediatric AMS were a lack of education about antibiotics and a lack of support from hospital management. Furthermore, an additional barrier in low- and middle-income settings was lack of recognition of AMS importance by senior doctors.[8] In addition, prescribing

behavior among colleagues and hierarchical structure within the medical field were found as factors under the social influences domain.[9]

In Thailand, AMS in the pediatric setting is not widely implemented, and the intervention is not highly accepted. Based on a previous study at a tertiary care center, overall acceptance of AMS programme recommendations for carbapenem de-escalation was only 57.8%.[10] Due to this low acceptance, implementation research is needed to explore the underlying reasons such as barriers and facilitators, and to inform how interventions should be adapted. In this study, researchers conducted implementation research on AMS across five pediatric units in academic hospitals in Thailand to identify barriers and facilitators of implementing AMS across different settings.

Methods

A qualitative study with semi-structured interviews was conducted in 2022 to gather data from healthcare providers. The Ethics Committee of Faculty of Medicine, Chulalongkorn University has approved the study (IRB. 236/65).

Study design

Semi-structured interview were conducted with healthcare providers. The qualitative study was conducted to identify 1) Barriers and facilitators of current AMS intervention at King Chulalongkorn Memorial Hospital (KCMH) where AMS implementation has been launched in pediatric setting since 2017, and 2) Barriers and facilitators to implement AMS at another 4 hospitals where AMS has not been established in pediatric setting. These include organizational context such as information technology support, staffing resources, organizational climate and culture, and leadership support. The interviews also assessed local context and barriers to implementation: stakeholder perceptions and attitudes, current antibiotic prescribing problems, and preferences for potential methods of implementation strategies.

Study Setting and Participants

The study was conducted by the Faculty of Medicine, Chulalongkorn University. We collected data from 5 academic tertiary care hospitals in Thailand. The site selection was recruited using convenient sampling, focusing on a center where pediatric infectious diseases specialists with less than

10 years of work experience. Interviews were conducted with both healthcare providers involved in antibiotic prescribing and steward teams who were AMS services providers.

Target population:

1) Health care providers (HCP)

Inclusion criteria: Healthcare providers who provide care at pediatric units at Department of Pediatrics, KCMH and another 4 hospitals (academic tertiary care hospitals: Charoenkrung Pracharak Hospital, Vachira Phuket Hospital, Trang Hospital, Hat Yai Hospital)

Exclusion criteria: Healthcare providers who worked less than 3 months of service at pediatric units.

2) Service providers of AMS teams (SP)

Inclusion criteria: Current healthcare providers who are steward teams at Pediatrics Department, KCMH, such as physicians, nurses, and pharmacists.

Exclusion criteria: Healthcare providers who had been involved with AMS services less than 3 months.

Sample size calculation for semi-structured interviews:

The initial target of the number of participants was to interview 20 healthcare workers and 10 AMS service providers. Interviews continued until thematic saturation was reached.[11] Ultimately, thematic saturation was achieved, and no new barriers or enablers were identified.

Interview Guide and Data Collection

An interview guide was created by the research team with guidance from a comprehensive literature review.[11, 12,13, 14] We used the CFIR model to inform interviews which were conducted among steward team and healthcare providers to identify barriers and facilitators of AMS implementation. Open-ended questions asked about current prescribing practices, prior education about antibiotic stewardship, and views about the stewardship program at the hospital. Participants also answered a questionnaire regarding AMS implementation and interventions (Supplemental material). The interview guide was piloted on two clinicians and revised based on feedback from the study team. Co-investigators (PW, TJ) conducted the interviews. Each semi-structured interview lasted 40-60 minutes. All participants provided informed consent to participate. The participant information sheet outlining

the study was provided to all potential participants. Participants were informed of their rights and confidentiality was assured. Their written consent was then obtained before each interview started. The interviews were audio recorded. The interviews began on 24 August 2022 and were completed on 6 Oct 2022. All interviews were conducted in Thai. Illustrative quotes were translated into English by one translator, then back-translated and reviewed by a second to ensure accuracy and maintain data integrity. The codebook was initially developed based on a review of the literature and the interview guide. It was then iteratively refined through a process of pilot coding and discussion among the research team.

Data Analysis

Transcripts were analyzed using MaxQDA (VERBI Software, 2022).[15] Transcripts were coded inductively in an iterative manner by three independent reviewers (SA, PW, TJ). We employed intercoder reliability checks using Cohen's Kappa >0.8. The coding discrepancies have been further discussed and were resolved by consensus. The research team used a combined inductive and deductive approach to code and analyze data. Main themes were identified through an inductive process while CFIR domains were used to deductively code for subthemes.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

In a total of 30 interviewees, there were 24 physicians and 6 pharmacists. Regarding gender, 63% of the participants were female. The mean age was 37 years (range 26-57). There were 14 (47%) healthcare workers who work directly related to infectious diseases. Demographic characteristics of the participants were shown in Table 1.

Four themes were identified characterizing the implementation of AMS in five pediatric units within academic hospitals in Thailand. These themes and subthemes are summarized in Table 2. Themes and subthemes linked to CFIR are presented in Figure 1.

The Impact of Organization and Individual Factors

Hierarchical Influence on Prescribing

In Thailand, the context of seniority refers to the traditional cultural value placed on respecting and honoring elders or those who hold higher positions in an organization. This concept is deeply rooted in Thai culture and is an essential aspect of social interactions and relationships. In a hospital setting, participants reported that the concept of seniority was significant. This affects the AMS when steward team suggests an intervention to pediatric residents, but the final decision depends on senior attending physician. Participants noted that the existing hospital system and culture did not readily support direct communication from the stewardship team to senior attending physician, potentially creating a barrier to implementing AMS recommendations.

"Well, sometimes you know the senior attendings might prescribe antibiotic, and you think, 'Maybe that's not the best choice,' but you don't really want to say anything. They have so much more experience." (HCP10)

"Among medical staff, including attending physicians, there can be differing opinions about the appropriate use of antibiotics. This can lead to inconsistent empirical antibiotic therapy. Senior staff members often have the final say in antibiotic selection, which can override recommendations made based on ASP guidelines." (HCP02)

Resource Limitations and Systemic Barriers

The participants reported the resource limitations such as lack of key personnel, competing priorities, lack of access to resources, problems with data and information systems, inadequate supply of laboratory diagnostic tests, and limited available antibiotic options.

"We as an ASP pharmacist had obstacles regarding the knowledge and number of key personnel. The expertise in antibiotics may still be limited to a small number of people. A challenge for us is the limited knowledge and number of staff with expertise, especially for complex antibiotic use." (HCP06)

"It's put the effort to track and report antibiotic use because our electronic medical record system is not fully supported. This made really hard to monitor trends and identify areas for improvement." (SP02)

Knowledge and Beliefs Impacting Prescribing

AMS stewards have to work to enhance the knowledge and understanding of healthcare providers regarding appropriate antibiotic use, including the latest guidelines and evidence-based practices. Individual behaviors and resistance to change are other factors, potetially due to established prescribing routines. The participants reported concerns of the frontline physicians about the benefits of the program, or fear of adverse outcomes and established prescribing habits which can act as barriers to change.

"A significant barrier is the prescribing behavior of healthcare providers and their fear of adverse outcomes. Due to the complexity of the cases in the tertiary care setting, frontline physicians may be hesitant to use narrower-spectrum antibiotics for fear of treatment failure or harm to the patient. While this is understandable, it can hinder the implementation of an ASP. (HCP04)"

To address this, participants suggested the importance of integrating AMS principles and rational antimicrobial use into medical education at the medical student level. This early exposure, they argued, would foster a culture of teamwork and promote improved patient care within the future healthcare system.

"We should start educating medical students about the stewardship program while they are still in medical school. This will prepare them to understand the importance of rational antibiotic use. When they graduate and start working, they will be ready to apply this knowledge immediately" (SP01)"

Changing healthcare workers' mindset to improve stewardship

Addressing Misconceptions and Building Trust

Changing healthcare workers' mindset to improve stewardship and identify and address concerns or barriers that healthcare workers may have regarding AMS. This could include concerns about patient satisfaction, fear of undertreatment, or lack of awareness. The participant from AMS team suggested to adjust mindset of the physician team. Different healthcare professionals may have varying perspectives and experiences regarding antibiotic stewardship. In some cases, physicians might have experienced conflicts with the stewardship team over specific patient cases, leading to a perception of

friction between the two parties. Also, they might have concerns about the time takes to consult or the potential delays in initiating antibiotics. The steward participants discussed correcting the AMS team is not the "antibiotic police"; instead, they play a vital and supportive role in promoting responsible and effective antibiotic use in healthcare settings. They help healthcare providers make informed decisions about antibiotic prescriptions tailored to each patient's condition.

"ASP team must understand that frontline clinicians may have concerns, anxieties, or be dealing with complex or unstable patients. Therefore, ASP team is there to assist in patient care, not to stop antibiotic therapy. (SP01)"

Navigating Authority and Autonomy

The steward team reported lacks the authority to directly intervene in prescribing practices. Consequently, their recommendations were ignored by individual clinicians. This emphasizes the need for effective communication and collaboration strategies. Social influences such as resistance from medical staff, lack of leadership, and perceived unhelpful attitudes of clinicians, also presented challenges. There is a tension between steward team and clinicians who feel their autonomy is being undermined and lead to resistance and a lack of buy-in from the individual clinicians.

"We can make suggestions, but at the end of the day, it's up to the primary physician to decide what to do. We don't have any real power to enforce." (SP06)

"Certainly, a major challenge is gaining the understanding of physicians from other specialties or the primary care team. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we change this perception and make primary teams see the ASP as a supportive specialty team focused on optimizing antimicrobial therapy? This is a significant challenge." (SP09)

Effective Communication and Collaboration for the success of AMS

Establishing Communication Channels for Stewardship Integration

Effective communication and collaboration among healthcare teams are crucial for the success of AMS. Issues related to communication gaps, interdisciplinary collaboration, and hierarchies within healthcare settings were reported. The service providers suggested that the effective strategies should be developed and established for sustainable communication channel for the steward team, ensuring that all medical professionals are aware of the scope and work of the steward team.

"Gaining the understanding of physicians from other specialties or the primary care team is crucial. Many healthcare providers perceive the ASP as a team that simply stops antibiotic use. How can we make the primary care team understand that the ASP is not a team that stops treatment, but rather a team that assists in patient care? We are essentially a specialty team focused on antimicrobial management." (SP01)

"I would like to find a more sustainable way to inform the prescribers about the stewardship program, then it will be easier to work together. (SP08)"

Overcoming Perceptual Barriers and Fostering Mutual Understanding

This subtheme focuses on the need to address negative perceptions and misconceptions about AMS teams and their role, and to build a foundation of mutual understanding and respect between AMS teams and other healthcare professionals. The participants reported that they might have experienced conflicts with the stewardship team over specific patient cases. The participants also discussed the importance of engaging other specialties with high antibiotic prescribing rates, such as hematology-oncology, critical care, and immunology, in the antimicrobial stewardship program.

"Antimicrobial steward team often have to negotiate with the prescribing physician. It can be difficult to immediately change these prescribing practices. However, what we can do is make adjustments after the initial antibiotic choice has been made, after a few days of monitoring, discuss the possibility of making adjustments. (HCP01)"

"ASP team should start suggestion by fostering mutual understanding. We are all working together to provide the best care for the patients." (SP02)

Dedication to Antimicrobial Stewardship Despite Resource Limitations

Intrinsic Motivation and Professional Fulfillment

Despite a lack of resources and staffing, AMS steward team reported a sense of professional fulfillment experienced. The participants discussed working as AMS team to prioritize patient safety by suggesting the appropriate use of antimicrobials. Furthermore, they are willing to continuously learn and stay updated on best practices in AMS, as well as to educate other healthcare professionals and patients about the importance of responsible antimicrobial use.

"I feel like this work can improve patient care, especially in terms of reducing antibiotic resistance. We can provide healthcare providers involved in the ASP with valuable experience that they can apply in their future roles. If, overall, things improve, that would be a rewarding outcome. (HCP01)"

"I feel like it's a big job. It requires a lot of collaboration to manage, and I think it will take a long time to see any changes. We need to continuously educate involving medical staff, however, seeing those results takes time. (HCP04)"

"I enjoy doing this because I'm constantly learning new things. Additionally, it can be seen as a strategy to encourage pharmacists to develop their skills." (HCP06)

The Reality of Workload

A reported drawback was the participants' feeling of resistance due to additional workload, and some expressed concern about how to effectively communicate with physicians.

" This task adds to the workload. I also feel it's a difficult and challenging task because it might involve dealing with many people and many groups like this. And they might have both those who agree and those who disagree." (HCP04)

"Concerning communication, generally speaking, even if we have a good reason, if our position is pharmacist, it's hard to speak up to doctors" (SP03)

Regarding the distributed questionnaire regarding AMS implementation and interventions, the top three ranking of the interest level among the participants to support AMS implementation at their hospital were: 1) A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure) 2) A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use; and 3) Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use. The top five ranking of the interest level in antimicrobial stewardship program interventions to be most effective in their hospital were: 1) De-escalation therapy 2) Guideline implementation, and 3) Antibiogram, 4) Prospective audit and feedback, and 5) Pharmacokinetics and pharmacodynamics application in antibiotic dosing.

Discussion

The barriers and facilitators of implementing AMS programme at pediatric units in academic hospitals in Thailand were identified. The major themes from this qualitative study were organizational hierarchical culture and individual behaviors, social influences aimed at improving healthcare workers' mindset, effective communication and collaboration, and the positive mindset of AMS programme team.

Our study identified organizational hierarchical culture and individual behaviors as key barriers to AMS implementation. These factors influence acceptance and adherence to AMS implementation. Understanding the specific cultural context of a healthcare setting is important for tailoring effective interventions. Studies from various settings consistently revealed inadequate knowledge and awareness of rational antibiotic use among physicians.[16] To address knowledge gaps, enhancing education on appropriate antimicrobial prescribing while in medical school is a key target for improvement.[17]

Antibiotic prescribing practices vary across countries. While many countries involve a wide range of healthcare providers in antibiotic prescriptions [16, 18], the prescribing practices in our study were distinct where specialists or senior physicians held primary decision-making authority. Consistent with a published study, hierarchical structures and a lack of recognition of AMS importance by senior doctors emerged as barriers in low- and middle- income settings.[9, 19] The findings demonstrated the long-standing culture of seniority hindered AMS adoption. Despite the existence of AMS policies in the studied hospitals, they were not consistently endorsed or applied in practice.

Many studies documented complex behavioral and social influences on antimicrobial prescribing.[20] Our findings align with other studies that have evaluated barriers in relation to clinical decision making. Prior studies reported physician insecurity in patients with severe or nondefinitive diagnoses.[21-23] Similar to pediatric setting, most pediatricians stated that non-prescription of an antibiotic to potentially severely ill children generated more fear and insecurity than the consequences of an unnecessary antibiotic prescription.[23] Given the high rates of antimicrobial resistance in our study setting, pediatricians also experienced anxiety about not prescribing broad-spectrum antibiotics. To resolve these challenges, adaptable, evidence-based interventions should be developed and implemented across various healthcare settings. An effective feedback tool also needs to be developed

and implemented to engage the healthcare provider and impact on the patients' clinical outcomes.[24] Our study reported that healthcare provider engagement was crucial for successful AMS implementation. ASP recommendations should be communicated collaboratively, focusing on improving patient outcomes rather than criticizing the practices or being perceived as the "antibiotic police".[12, 25] From the previous study, formalized antibiotic stewardship meetings and ward rounds on a continuous and regular basis is one of the effective AMS intervention.[26] The AMS team can facilitate interdisciplinary rounds to address complex cases, bringing together expertise from specialists, infectious disease physicians, pharmacists, and other healthcare professionals.[27] This collaborative approach encourages shared decision-making and can lead to more rational antibiotic use.

A recent national survey in Thailand indicated that nearly 90% of hospitals had an ASP in 2021, often with a multidisciplinary team.[28] However, there is a shortage of ASP team members nationwide. Most team members are general practitioners or pharmacists lacking formal infectious disease training.[29] Understaff and underprioritizing of ASP are also global challenges.[30] Despite resource constraints and heavy patient workloads in the region[16], our study found that the stewardship team maintained a positive attitude toward combating antimicrobial resistance and was committed to professional development aligning with findings from previous study.[31] To further enhance their efforts, robust support systems, including hospital administrator, adequate laboratory capabilities, and improved information technology infrastructure, are essential.[29]

For the implication, antibiotic stewardship involves organization and hospital policy, hospital staff and antibiotic prescribers, local context in each setting, and individual behavior change should be considered. Overall, the success of antimicrobial stewardship programs relies on understanding and addressing the perspectives and concerns of healthcare workers. Creating a positive and supportive environment, providing ongoing education, and recognizing the contributions of those involved are essential components of a successful stewardship initiative. It requires a combination of educational, organizational, and cultural interventions. Tailoring strategies to the specific challenges and culture of the healthcare environment is crucial for success. The Behavior Change Wheel (BCW) is a systematic framework designed to guide the development of effective interventions.[32] It works by first requiring a thorough understanding of the target behavior using the COM-B model (Capability, Opportunity,

Motivation). For example, if a key barrier is someone's beliefs about the behavior, potential interventions might focus on persuasion, modeling, or education to change those beliefs. Similarly, if a lack of resources is identified as a barrier, an enablement intervention, such as endorsing a supportive hospital policy or providing staff and equipment, could be implemented.

Our findings highlight specific challenges and opportunities for AMS implementation within the context of inpatient pediatric care. Key strengths of the study include identifying institutional and cultural impediments to AMS adoption, especially in low- and middle-income situations. Furthermore, it identifies the dedication and professional fulfillment of AMS teams, which can be leveraged to improve AMS initiatives. However, it is important to acknowledge several methodological limitations. Firstly, the findings may not be directly transferable to all settings due to differences in organizational structure, resource availability, and patient populations. Secondly, conducting qualitative research in a hierarchical corporate culture presents challenges, potentially leading to power dynamics influencing participants' responses and a reluctance to express opinions. Lastly, there is the possibility of social desirability bias influencing participants' responses during the interviews. Although we ensured anonymity and confidentiality to minimize this bias, we acknowledge that it may not have been entirely eliminated.

Conclusions

The implementation of antimicrobial stewardship in pediatric settings is challenging. The key barriers to focus were organization hierarchical culture and perception of healthcare workers. The next steps for implementing AMS programs in Thai pediatric hospitals could involve integrating AMS principles into medical education, fostering an approach to promote shared decision-making regarding rational antibiotic use, and improve healthcare workers' mindset toward stewardship.

Contributor

SA and TJ conceived and designed the study. PW and TJ conducted and interviewed the participants. SA, PW, and TJ analyzed the data and interpreted the themes. TP supervised the study. SA wrote the first draft of the manuscript. All authors thoroughly reviewed and approved the manuscript. SA is responsible for the overall content of the manuscript as guarantor.

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Competing interests

The authors have no competing interests to declare.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication

Not applicable.

Ethics approval

This study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB no. 0236/65). All participants provided informed consent to participate in the study.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data availability statement

Anonymized data can be provided upon reasonable request. All study data consists of notes from staff interviews. The source data is confidential and not available for dissemination.

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Table 1. Baseline Characteristics of the 30 Interview Participants

Hospital levels	Number of interviewees	Profession	Gender	Mean age (range)
Healthcare workers	20	Physician 19 Pharmacist 1	Male 3 Female 7	39.2 (29-57)
AMS service providers	10	Physician 5 Pharmacist 5	Male 8 Female 12	36.3 (26-56)
Overall	30	Physician 24 (80%) Pharmacist 6 (20%)	Male 11 (37%) Female 19 (63%)	37.0 (26-57)

Table 2. Summary of themes and subthemes

Themes	Subthemes	Related CFIR Domains
The Impact of Organization and Individual Factors	Hierarchical Influence on Prescribing	Inner Setting - Culture
	Resource Limitations and Systemic Barriers	Inner Setting - Available Resources
	Knowledge and Beliefs Impacting Prescribing	Characteristics of Individuals - Implementation Team Members, Capability
Changing healthcare workers' mindset to improve stewardship	Addressing Misconceptions and Building Trust	Characteristics of Individuals - Implementation Team Members
	Navigating Authority and Autonomy	Inner Setting – Relational Connections, Communications
Effective communication and collaboration among healthcare teams	Overcoming Perceptual Barriers and Fostering Mutual Understanding	Characteristics of Individuals - Implementation Team Members
	Establishing Communication Channels for Stewardship Integration	Inner Setting - Communications
Dedication to antimicrobial stewardship despite resource limitations	Intrinsic Motivation and Professional Fulfillment	Characteristics of Individuals – Motivation, Need
	The Reality of Workload	Intervention Characteristics - Complexity, Inner setting - Implementation Climate

Figure 1. Themes and subthemes linked to CFIR

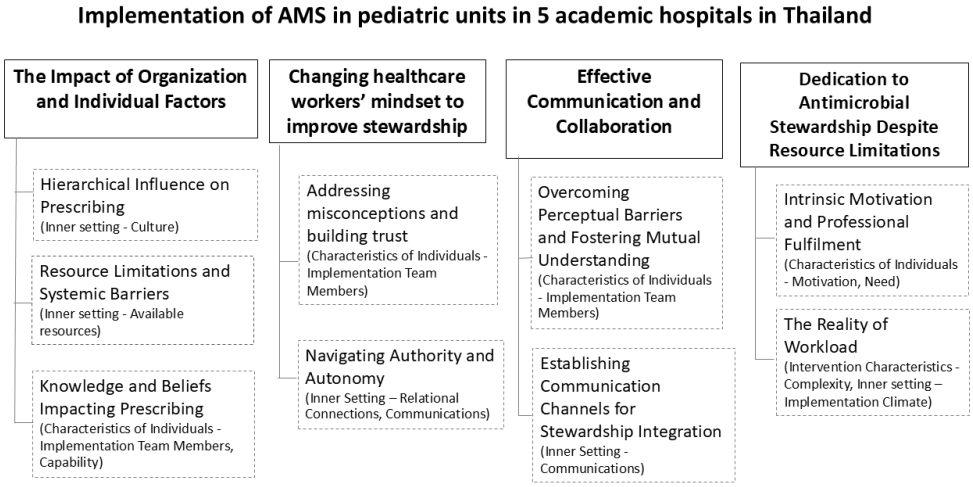

Figure 1. Themes and subthemes linked to CFIR

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Supplemental material: Questionnaire

A. Please rank the following factors in order of their importance in implementing in your hospital to support the appropriate use of antibiotics (Rank from 1 as most important to 7 as least important)

- A hospital policy and a formal organizational structure responsible for AMS e.g., a multidisciplinary committee focused on appropriate antibiotic use, pharmacy committee, patient safety committee, or other relevant structure
- A formal antimicrobial stewardship programme accountable for ensuring appropriate antibiotic use.
- Available multidisciplinary AMS team e.g., greater than one staff member supporting clinical decisions and implementing a comprehensive programme to ensure appropriate antibiotic use.
- Physician is the leader of antimicrobial stewardship activities.
- An information technology (IT) system that supports antimicrobial stewardship activities.
- Salary support for individuals working in antimicrobial stewardship.
- Hospital policies and administrative support.
- Others (please specify) ……..

B. Which of the following antimicrobial stewardship interventions do you think is most suitable and beneficial for promoting the appropriate use of antibiotics in your hospital?

ASP interventions	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Education					
Guideline implementation					
Antibiotic restriction and authorization					
Prospective audit and feedback					
IV-to-PO conversion					
Outpatient parenteral antimicrobial therapy					
De-escalation therapy					
Shortening duration of antimicrobial therapy					
Antibiogram					
Cascade antimicrobial susceptibility report					
Improve rapid diagnostic test					
Pharmacokinetics and pharmacodynamics application in antibiotic dosing					
Others (please specify) ……..					